FRD Activities Report
June 2000

Research Programs

Vertical Transport and Mixing Experiment-Chemical and Biological Non-proliferation Program 2000 (VTMX-CBNP 2000)

FRD's role in the VTMX-CBNP project continues to expand. Plans now call for using all 121 of FRD's whole air samplers, 6 of FRD's 8 mobile SF_6 analyzers, all of FRD's available sonic anemometers (2), and FRD's mobile radar profiler and RASS system. The whole air analysis system has been brought out of standby mode and is nearly fully operational. The mobile analyzers are now fully operational, but are undergoing modification to make them safer and more transportable (see next paragraph). Examination of the whole air sampler containers resulted in the discovery that the containers are beyond their useful life. New containers are being fabricated and the sampling mechanisms will be transferred from the old containers to the new containers. A few new samplers will also be built for replacements should any existing sampler fail during the upcoming tests. Bag cleaning and whole air sampler checkout will occur next month. (Kirk.Clawson@noaa.gov and staff)

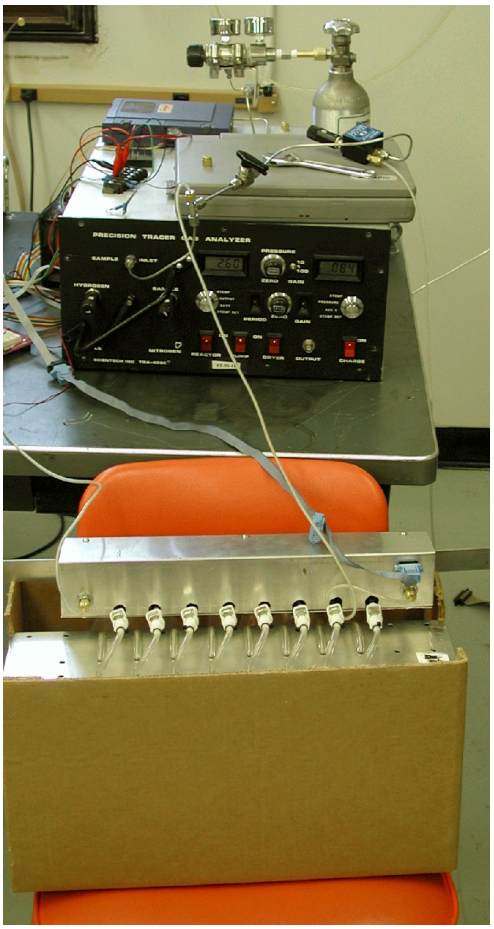


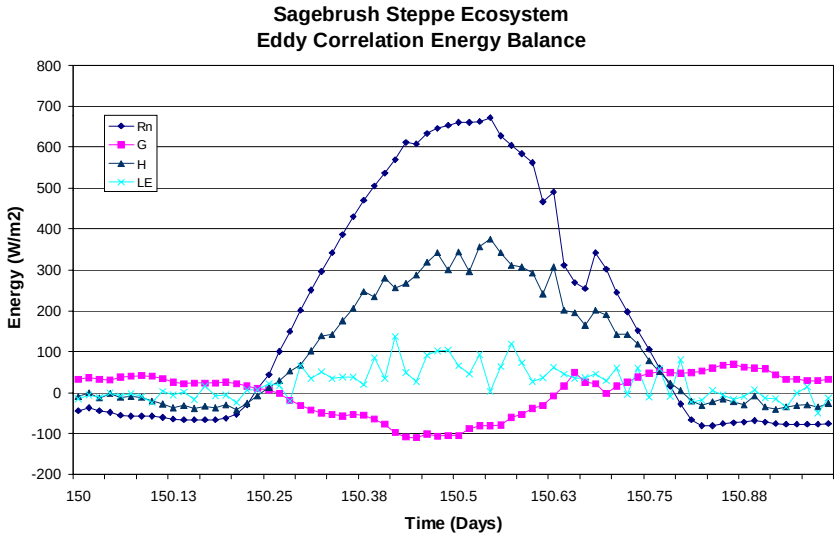
Figure 1. Modified mobile SF_6 analyzer under development.

As part of the preparations for the VTMX study, the SF_6 continuous analyzer system has been redesigned to make it smaller and easier to operate. A mock up of the new system was installed in a vehicle for two days this month for review by the FRD staff. A number of good comments and suggestions were generated and a decision made to go ahead with the conversion. A data acquisition card has been purchased and is being tested. The software to use the new data card and the increased capabilities of the system is in the testing stage. The electronic interface between the TGA-4000 and the computer system is prototyped and being tested. Modifications to the gas flow system on all analyzers are in progress. We hope to have one system completely converted and operating in the next 1 to 2 weeks and plan too have all systems converted by this fall. (Roger.Carter@noaa.gov, James Angell)

Sagebrush Steppe Ecosystem Flux Site

The data have been pouring in from the eddy correlation system installed in FRD's permanent flux site in local sagebrush steppe ecosystem. This month, significant progress was made in analyzing the data. Figure 1 shows the energy balance for the 29th of May (DOY 150). The traces of soil, sensible, and latent heat are indicative of the limited water available in the root zone for evapotranspiration. Total precipitation for all of the month of May was only 23 mm, most of which fell on May 5 and 6.

Work is proceeding on incorporating the WPL water vapor correction for carbon dioxide. (Kirk.Clawson@noaa.gov)



The flux site was visited on 7 June by Doug Johnson of the USDA-ARS, Neil West of Utah State University, and Jay Anderson of Idaho State University. The latter two are ecologists and Dr. Johnson is a range scientist cooperating with FRD on the joint eddy correlation/Bowen ratio flux site. The purpose of the visit was to determine the representativeness of the flux site in relation to the much larger region of sagebrush steppe ecosystem. The group learned of long-term vegetation monitoring sites on near the flux site that have been monitored for approximately 50 years. Plans were made to sample the flux site in early July for comparison to the nearby long-term vegetation monitoring sites. (Kirk.Clawson@noaa.gov)

SHOWEX

In an effort to understand air-sea energy exchange under light wind conditions, aircraft data acquired by LongEZ N3R during the Shoaling Waves Experiment (SHOWEX) are analyzed. N3R conducted numerous low-level (~ 10 m) east-west transits from the Outer Banks of North Carolina to the edge of the Gulf Stream on 20 November 1999 (Table 1). Six legs were flown over the same track over the course of the flight. Each leg was approximately 100 km in length and took about 30 to 35 minutes to fly.

The region was dominated by a high pressure system located off the Nova Scotia coastline. Horizontal surface pressure gradients were generally weak and skies were clear. In general, the aircraft observed winds were from the south to southwest with speeds ranging from near calm to about 4 m s^{-1}. Near the edge of the Gulf Stream, wind speeds generally increased and were in the range of 5 to 8 m s^{-1}. Tim Crawford, who piloted N3R, reported relatively smooth seas.

Table 1. Low-level flux legs acquired by the LongEZ (N3R) during SHOWEX on 20 November 1999.

Leg	Key	Start (UTC)	End (UTC)	Duration (MM:SS)	Distance (km)	Heading ± 1σ (deg)	Z ± 1σ (m)
1	●	14:04:35	14:34:55	30:20	97.4	103 ± 4.4	9.9 ± 2.2
2	●	15:46:54	16:14:06	27:12	92.6	278 ± 2.4	7.7 ± 2.2
3	●	16:20:23	16:57:00	36:37	114.7	104 ± 5.2	7.3 ± 2.1
4	●	16:58:25	17:32:08	33:43	112.9	277 ± 3.0	8.2 ± 2.1
5	●	17:34:08	18:09:33	35:25	113.9	103 ± 2.6	6.4 ± 2.7
6	●	18:10:56	18:43:53	32:57	111.9	279 ± 3.4	7.0 ± 1.8

Using eddy correlation techniques, wind stress, friction velocity, and drag coefficient were computed from the 50-Hz data as discrete 60-s blocks (~ 3 km). The wind stress τ is computed using the following equation:

$$\tau = -\rho\left(\overline{u'w'}^2 + \overline{v'w'}^2\right)^{1/2} \quad (1)$$

where ρ is the mean air density. The friction velocity u_* is simply computed by dividing the stress

$$u_* = \sqrt{\frac{\tau}{\rho}} \quad (2)$$

by the air density, i.e.,

The drag coefficient C_D is simply the ratio of the square of the friction velocity to the square of the mean wind speed, i.e.,

$$C_D = \frac{u_*^2}{U^2} \quad (3)$$

Scatter plots of friction velocity and drag coefficient for these six flight legs are shown in Figure 1. Values of u_* range from 1 to 20 cm s^{-1}. Considerable scatter is observed and exponential fits of the form $u_* = a \exp(b\,U)$ yield values for the slope (b) in the range of 0.25 to 0.30. However, correlation coefficients for these fits are not very good. The scatter plot shows considerably more

scatter as a function of the mean wind speed. Various fits of C_D to U have been computed by numerous investigators. Inevitably, these various fits contain significant scatter. The same is true for the scatter plot of C_D versus U in Figure 1. An interesting feature is seen, however, when U is less than 2 m s^{-1}. Most of these points were observed near the end of Leg 1 near the beginning of the flight. In this case, C_D appears to be inversely proportional to U. It should be pointed out that the mean wind speed was not corrected to U_{10}, i.e, the 10-m wind velocity. (Jerry.Crescenti@noaa.gov, Jeff French, Tim Crawford)

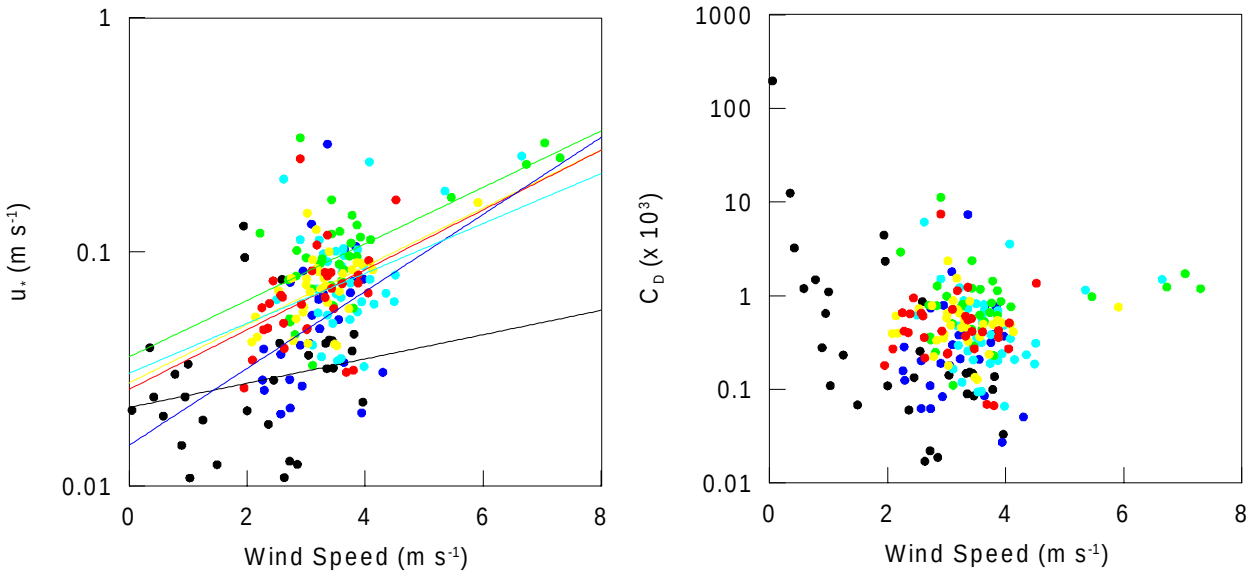


Figure 1. Scatter plot of friction velocity u_* and drag coefficient C_D as a function of mean wind speed for six 10-m flight legs on 20 November 1999 during SHOWEX. Exponential fits are shown for u_* as a function of U.

Hurricane Balloons

Globalstar satellite telephones have been selected for data communications in place of the failed Iridium satellite phone system. The phones have been tested for signal strength inside the PVC enclosure and have a good clear voice signal. Since the signal is digital, Code Division Multiple Access (CDMA), it therefore provides a very quiet voice signal and allows much greater data throughput rate. Data transmission will be at 9600 bits per second rather than the 2400 bits per second that was planned for the Iridium phone system. Testing of actual data transmission will not take place until some time in the 4th quarter of 2000 when point-to-point asynchronous data capability is introduced for Globalstar.

The purchase of a Globalstar telephone completes the selection of components to be used inside the

transponder. These components are attached to the transponder mounting plate and enclosed in the balloon transponder housing. The complete enclosure is fabricated from PVC pipe and PVC plates and is fitted inside the high strength Spectra balloon shell. This enclosure will provide not only gathering and communications of balloon data, it will also provide the necessary mechanical interface between the internal bladders, the balloon shell and the atmosphere. (Randy.Johnson@noaa.gov)

ET Probe

The proposal entitled *Development and Deployment of an Extreme Turbulence (ET) Probe for Hurricane and High Wind Research* to the Office of Naval Research's (ONR) Coupled Boundary Layers/Air-Sea Transfer (CBLAST) research initiative has been tentatively approved for funding. (Tim.Crawford@noaa.gov, Randy Johnson, and Jerry Crescenti)

CBLAST-LOW

The proposal entitled *Determination of the Spatial Variation of the Atmosphere and Ocean Wave Fields in Extremely Light Wind Regimes* to the Office of Naval Research's (ONR) Coupled Boundary Layers/Air-Sea Transfer (CBLAST) research initiative has been tentatively approved for funding. (Jerry.Crescenti@noaa.gov, Tim Crawford, and Jeff French)

P3 Turbulent Flux Research in Hurricanes

The proposal entitled *Air-Sea Flux Estimation in High Wind Boundary Layers* to the Office of Naval Research's (ONR) Coupled Boundary Layers/Air-Sea Transfer (CBLAST) research initiative has been tentatively approved for funding. (Jeff.French@noaa.gov, and Tim Crawford)

Central California Ozone Study (CCOS)

Surface meteorological data acquired by the nine towers deployed for the Central California Ozone Study (CCOS) are being downloaded on a regular basis. Quality control screening efforts have shown that these tower systems are working exceptionally well. However, a cup anemometer was replaced at the Piedras Blancas Lighthouse because the starting threshold for the instrument was compromised by the corrosive effects of sea salt. The same behavior was seen near the end of June for the cup anemometer at the Point Reyes National Sea Shore. These instruments have been replaced and the invalid data has been flagged accordingly.

Meanwhile, the radar and sodar systems continued to be plagued by a host of annoying problems. A 25,000 BTU air conditioner was installed to keep the electronics trailer cool during the hot summer days. Afternoon temperatures almost always exceed 30 °C and often approach 35 to 38 °C for the maximum. Efforts continue to keep these systems running with minimal loss of data. (Jerry.Crescenti@noaa.gov, Randy Johnson, Neil Hukari, Shane Beard, and Tom Strong)

Refractive Turbulence Project

Plans have been finalized for a short field experiment based at IDA for the first three weeks of August. Krzysztov Haman (Warsaw University) and Owen Cote (USAF Research Laboratory) will participate in this experiment. Dr. Haman will mount two versions of his Ultra-Fast Temperature (UFT) sensor on the LongEZ. This probe responds to temperature fluctuations at 10^{-4} s, with a resolution of 0.1 C. Data from this will be compared with the ARL/FRD designed and built high-resolution temperature sensor. This probe is designed to respond to fluctuations of 0.005 C at 0.04 s. Both instruments will prove useful for measuring small temperature perturbations on small spatial scales. (Jeff.French@noaa.gov, Tim Crawford, and Randy Johnson)

Model Validation Program (MVP)

Work continued in June on an evaluation of the RAMS mesoscale simulations that were run for the three MVP sessions conducted at the Cape Canaveral Air Station. The archived simulations are quite large, requiring 14 CD's. A program has been written that can interpolate the gridded RAMS output to a specified latitude, longitude, and altitude. One problem with some of the Cape Canaveral RAMS simulations is that the surface heat fluxes and similarity parameters such as the friction velocity were not saved in the output. This makes it difficult to extrapolate the winds and other variables below the lowest model level at about 35 m AGL. (Richard.Eckman@noaa.gov)

Cooperative Research with INEEL

INEEL Emergency Operations Center (EOC) Support

FRD staff participated in an INEEL Emergency Operations Center (EOC) drill on 21 June. The scenario involved a transportation accident associated with radiological materials. The MDIFF model was used to provide dispersion estimates for potential releases from the accident site. At one point during the drill, a request was made for radiological dose estimates for the accident. However, MDIFF currently cannot compute dose estimates at arbitrary locations, because its radiological database includes only known inventories at fixed INEEL facilities. It is not clear whether DOE will request an MDIFF upgrade to allow dose calculations from arbitrarily selected locations. (Richard.Eckman@noaa.gov, Jeff French)

Over the past few years, it has become apparent that a significant portion of FRD's support to the INEEL Emergency Operations Center is associated with wildfires at the site. An effort is now under way to develop a wildfire modeling capability at FRD. Several different wildfire models of varying complexity have been developed by groups around the world. The simplest treat the spreading fire as an ellipse, whereas the more complex models are often integrated with a Geographic Information System (GIS). Any model used at FRD should be able to take advantage of the wind data available from the INEEL tower network. (Richard.Eckman@noaa.gov)

INEEL Mesoscale Modeling

As reported last month, large differences were observed in the near-surface soil moisture reported by the Eta and RUC (Rapid Update Cycle) models. The MM5 mesoscale forecasts for Southeast Idaho being run at FRD often show quite different behavior depending on whether the soil moisture is initialized from the Eta or RUC models. Several emails were sent out in an attempt to determine why the models display such large differences in soil moisture, but the model developers did not seem to be particularly interested. Some of the faculty in the Biology Department at Idaho State University (ISU) have been collecting soil moisture measurements at INEEL and have provided a sample data set for one of their sites. They do not collect the soil-moisture data frequently enough to allow it to be directly used in the MM5 initialization, but the data are useful for determining whether the Eta or RUC soil moisture is more realistic. ISU also has some soil-moisture data for irrigated plots, which will be helpful for the eastern side of the Snake River Plain where irrigated farmland is prevalent.
(Richard.Eckman@noaa.gov)

Wind Profiler repair

Once again, an audio speaker on the 915MHz wind profiler located on the INEEL has failed. The service center repaired it a no cost since it was rebuilt less than a year ago and they felt the failure may be the result of a poor repair the first time. We have decided to run the speakers at a slightly reduced power level, hoping that this will increase the lifetime on the speakers.
(Roger.Carter@noaa.gov, Tom Strong)

Other Activities

High School Science Action Team

A high school science action team (SAT) visited FRD on June 19 to learn more about meteorological processes that govern fog formation and dispersion. The SAT, sponsored by the INEEL, is lead by Mark Gabrylczyk, a teacher from Idaho Falls High School. The team is comprised of high school students: Stephanie Crapo (Skyline High School), Keith Mecham (Snake River High School), Stacey Peterson (Blackfoot High School), and Lisa Podany (Idaho Falls High School). Their task is to propose solutions for a unique problem facing a food processing plant in Blackfoot which produces dehydrated potatoes. The moisture which is extracted from the potatoes in the dehydration processes is released into the atmosphere via smoke stacks which are only about 12 m in height. In the winter during humid inversion conditions, the moisture in the plume quickly saturates and stagnates in the vicinity of the plant. Just downwind of the stacks is U. S. Highway 26. In many instances during these conditions, visibility along this stretch of road is reduced to near zero. This, of course, has contributed to a number of automobile accidents. The SAT has been tasked to try to come up with cost effective solutions to reduce and/or eliminate this micrometeorological problem.
(Jerry.Crescenti@noaa.gov).

OAR Outreach Committee

Jerry Crescenti has joined OAR's Outreach Committee and replaces Barbara Shifflett (ATDD) as the ARL representative to the group. More information about OAR's outreach efforts can be found at http://www.oarhq.noaa.gov/rm/outreach. (Jerry.Crescenti@noaa.gov)

Proposals

Measurement of Carbon Dioxide and Atmospheric Turbulent Fluxes and Sea Surface Properties in a Coastal Regime by Gennaro H. Crescenti, Timothy L. Crawford, Jeffrey R. French, and Douglas C. Vandemark. Notice of Intent submitted to NASA Research Announcement NRA-00-OES-05.

Papers

Clawson, K. L., D. A. Johnson, and N. Saliendra, 2001: Initial comparison of fluxes from Bowen ratio and eddy correlation instrumenation over a sagebrush steppe ecosystem. *Eleventh Symposium on Meteorological Observations and Instrumentation*, Albuquerque, NM, Jan. 14-19, Amer. Meteor. Soc., abstract submitted.

Crawford, T. L., G. H. Crescenti, and J. M. Hacker, 2001: Small Environmental Research Aircraft (SERA): The future of airborne geoscience. *Eleventh Symposium on Meteorological Observations and Instrumentation*, Albuquerque, NM, Jan. 14-19, Amer. Meteor. Soc., abstract submitted.

Crawford, T. L. and R. J. Dobosy. Accuracy and Utility of Aircraft Flux Measurement Systems. In *Biospheric Feedbacks in the Climate System and the Hydrological Cycle*, Editors J. H. C. Gash and P. Kabat, Springer-Verlag Berlin Heidelberg, New York. Revised and accepted.

Crawford, T. L., R. J. Dobosy, D. L. Auble, G. H. Crescenti, and R. C. Johnson, 2001: The extreme turbulence (ET) probe for measuring boundary-layer turbulence during hurricane-force winds. *Eleventh Symposium on Meteorological Observations and Instrumentation*, Albuquerque, NM, Jan. 14-19, Amer. Meteor. Soc., abstract submitted.

Eckman, R. M., 2000: Evaluation of the REEDM climatological turbulence algorithm using aircraft measurements. NOAA Technical Memorandum OAR/ATDD-234, Silver Spring, MD, 39 pp.

French, J. R., T. L. Crawford, and R. C. Johnson, 2001: A high-resolution temperature probe for airborne measurements. *Eleventh Symposium on Meteorological Observations and Instrumentation*, Albuquerque, NM, Jan. 14-19, Amer. Meteor. Soc., abstract submitted.

French, J. R., G. H. Crescenti, T. L. Crawford, and E. J. Dumas, 2000: Data Report: LongEZ (N3R) participation in the 1999 Shoaling Waves Experiment (SHOWEX). NOAA

Technical Memorandum OAR ARL-???, Silver Spring, MD, 51 pp., submitted for internal review.

Johnson, D. W., S. Osborne, R. Wood, K. Suhre, R. Johnson, S. Businger, P. K. Quinn, A. Wiedensohler, P. A. Durkee, L. M. Rusell, M. O. Andreae, C. O'Dowd, K. J. Noone, B. Bandy, J. Rudolph, and S. Rapsomanikis, 2000: An overview of the Lagrangian experiments undertaken during the North Atlantic Regional Aerosol Characterization Experiment (ACE-2). *Tellus*, **52B**, 290-320.

Johnson, R., S. Businger, and A. Baerman, 2000: Lagrangian air mass tracking with smart balloons during ACE-2. *Tellus*, **52B**, 321-344.

Johnson, Randall C., Roger G. Carter, Steven Businger, Gary Barnes, and Joost Businger, 2001: Improved Smart Balloon To Better Characterize Hurricane Boundary-Layer Inflow. *Eleventh Symposium on Meteorological Observations and Instrumentation*, Albuquerque, NM, Jan. 14-19, Amer. Meteor. Soc., abstract submitted.

Watson, T. B., G. H. Crescenti, R. C. Johnson, B. R. Reese, R. G. Carter, S. D. Turley, B. Grim, and C. A. Biltoft, 2000: The Over-Land Along-Wind Dispersion (OLAD) field experiment. NOAA Technical Memorandum OAR ARL-235, Silver Spring, MD, 141 pp.

Papers Reviewed

By Kirk Clawson: Areal measurements of ozone, water, and heat fluxes over land with different surface complexity, using aircraft. Presentation, 6th Int'l Conf. On Air-Surface Exchange. 3-7 July 2000. Edinburgh, UK.

Awards

Crescenti, G. H., 1998: The degradation of Doppler sodar performance due to noise: A review. *Atmos. Environ.*, **32**, 1499-1509. Paper submitted for the OAR Outstanding Paper Award (review category).

Travel

Randy Johnson attended the AMS 24th Conference on Hurricane and Tropical Meteorology in Fort Lauderdale, Florida, the first week in June.

Tom Strong traveled to the Carrizo Plain site for Central California Ozone Study (CCOS) June 13 - 16, where he downloaded data from the sodar and radar, and took photos for site documentation. He also discovered that the air conditioning system was not adequate efficient functioning of the instruments and computer systems. One of the meteorological instruments at the Piedras Blancas station was repaired.

On June 26 - 29, Tom Strong again went to the Carrizo Plain site for the CCOS to install a new

and much more powerful air conditioning system. Unfortunately, the system did not function properly, and arrangements are now being made for repair/replacement.

Visitors

Doug Johnson and Neil West from Utah State University and Jay Anderson from Idaho State University, 7 June 2000, visited the FRD permanent eddy correlation flux site.

New Employee

The vacant position for Physical Scientist has been filled by Debbie J. Lacroix. Debbie has been with the Washington State Department of Ecology for the past nine years and has an impressive background in chemical analysis. Although her former co-workers are sad to see her leave, we at FRD are delighted to welcome her to our laboratory and to Idaho Falls. She will begin her duties on July 16.